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Unes et al.

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(54) **FUEL PUMP RETAINER**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 234 days.

(21) Appl. No.: **14/028,595**

(22) Filed: **Sep. 17, 2013**

(65) **Prior Publication Data**

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F02M 37/04 (2006.01)
F02M 39/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F02M 39/02*** (2013.01)

(58) **Field of Classification Search**
CPC F04B 39/16; F02M 37/22; F02M 37/221; F02M 37/223; F02M 2037/225; F02M 2037/226; F02M 2037/228
USPC 123/495; 417/572; 210/416.4, 485
See application file for complete search history.

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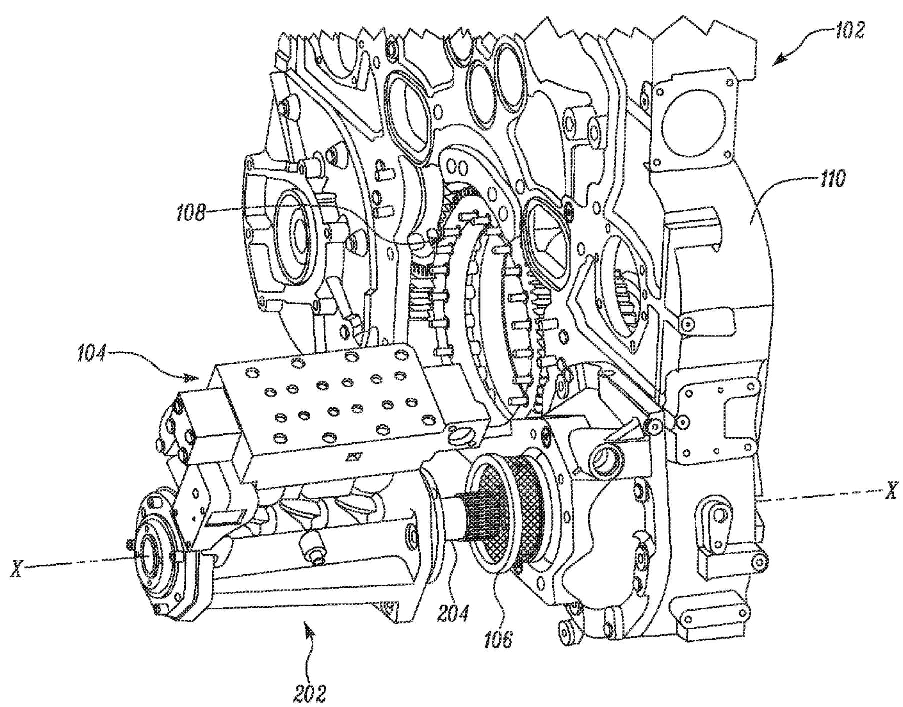
(57) **ABSTRACT**

A fuel pump is disclosed. The fuel pump includes a housing. Further, the fuel pump includes a rotatable pump shaft disposed within the housing. One end of the rotatable pump shaft is attachable to a gear. The housing also includes a retainer disposed within the housing and located about the pump shaft. The retainer includes a first rim and a second rim that are spaced apart from each other. The retainer also includes a side wall extending between the first and the second rims. Further, the side wall of the retainer defines a first volume and a second volume within the housing. The side wall of the retainer has a plurality of apertures configured to allow a fluid flow from the first volume to the second volume while retaining particulate contaminants larger than a size of the apertures within the first volume.

20 Claims, 6 Drawing Sheets



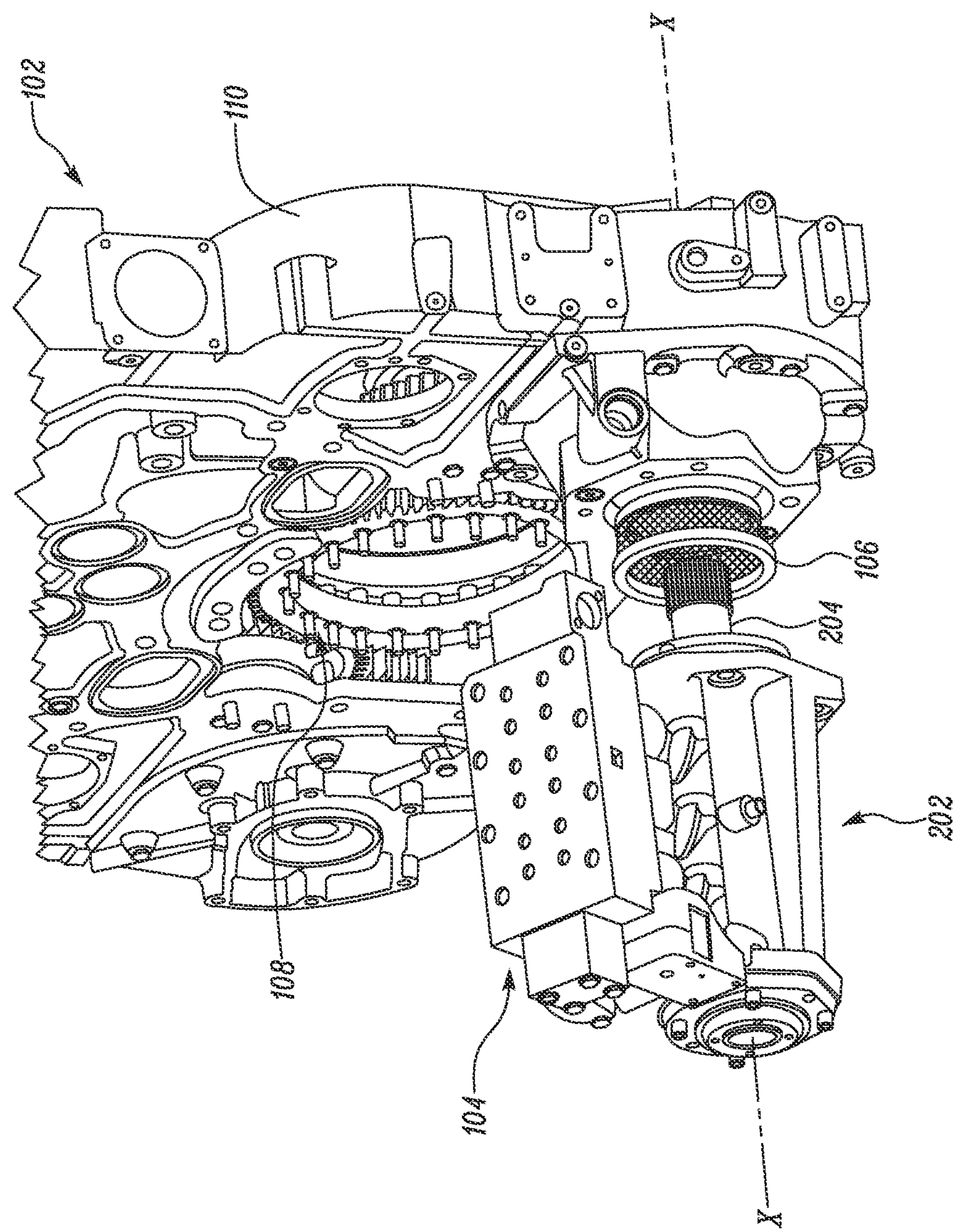
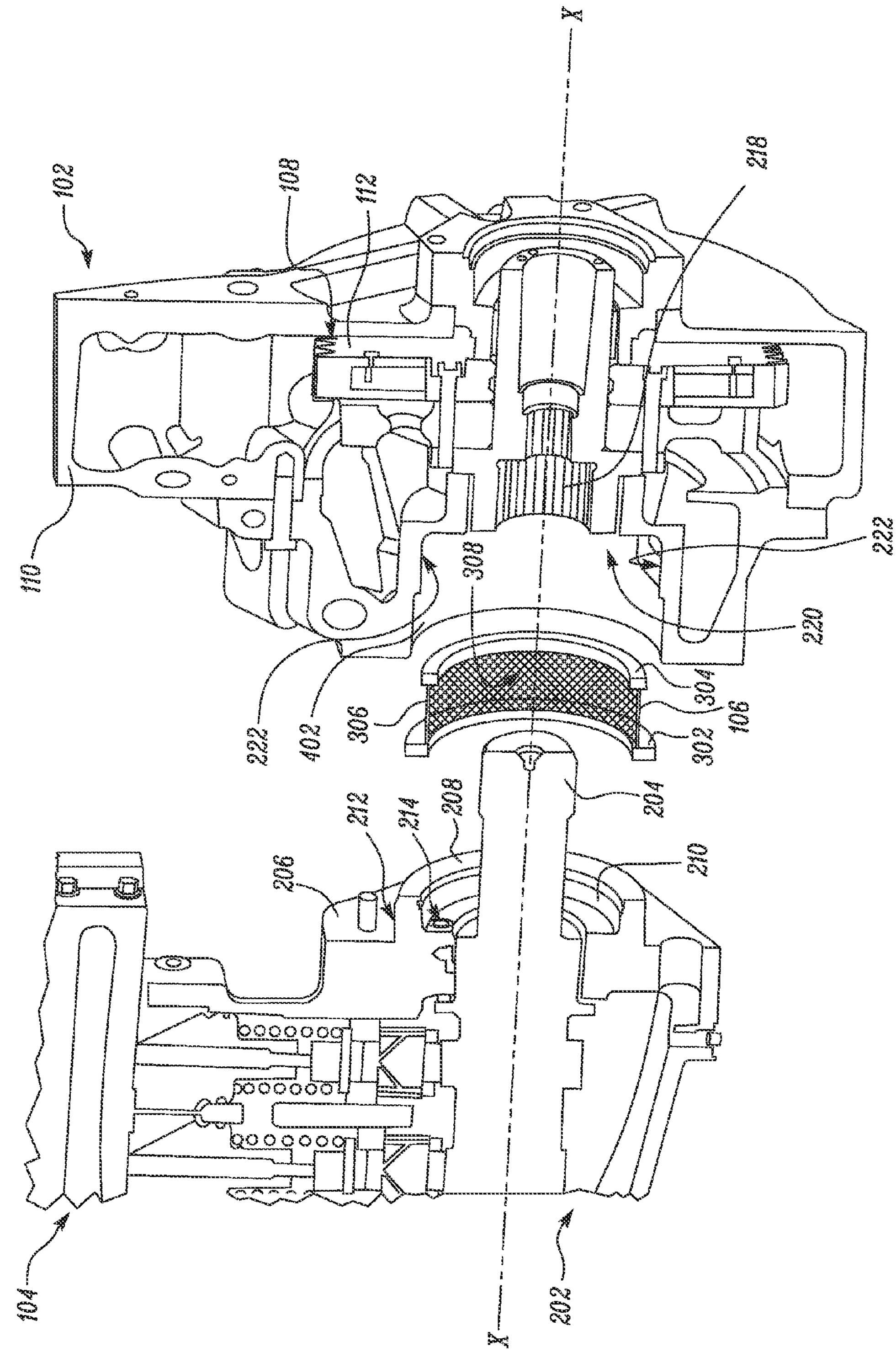


FIG. 1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102
108
112
218
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212
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210
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202
X

FIG. 2

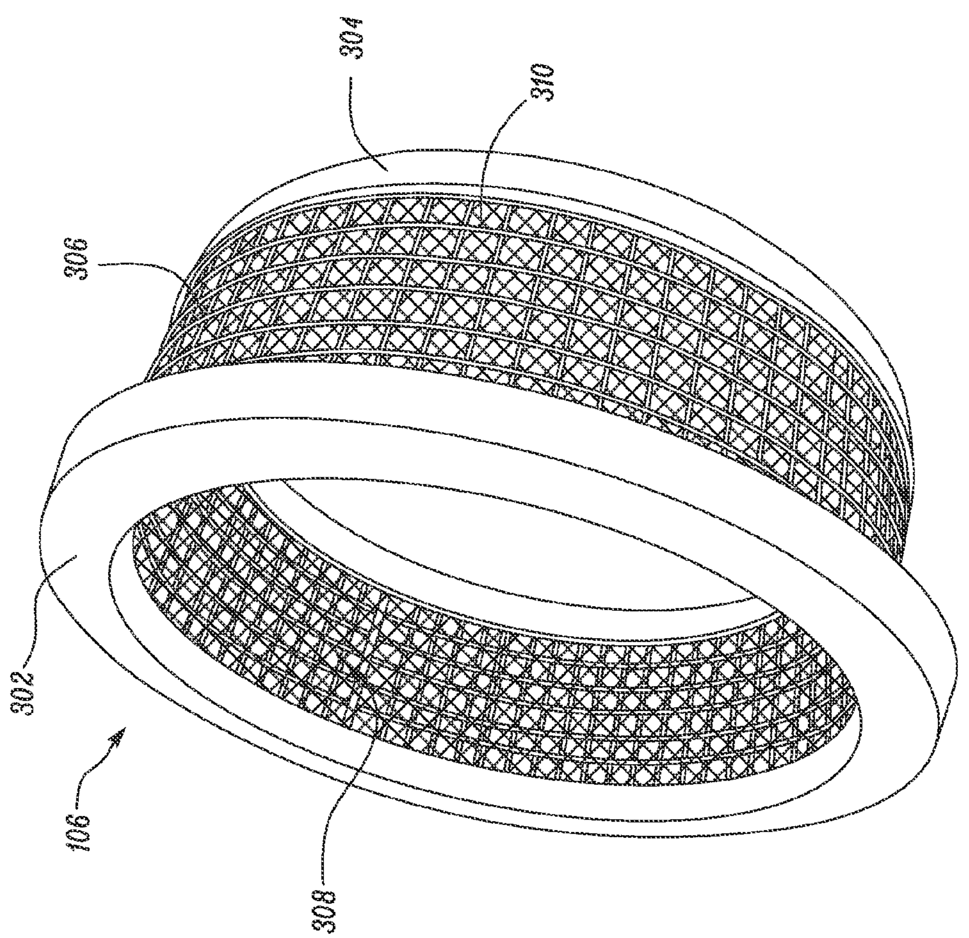
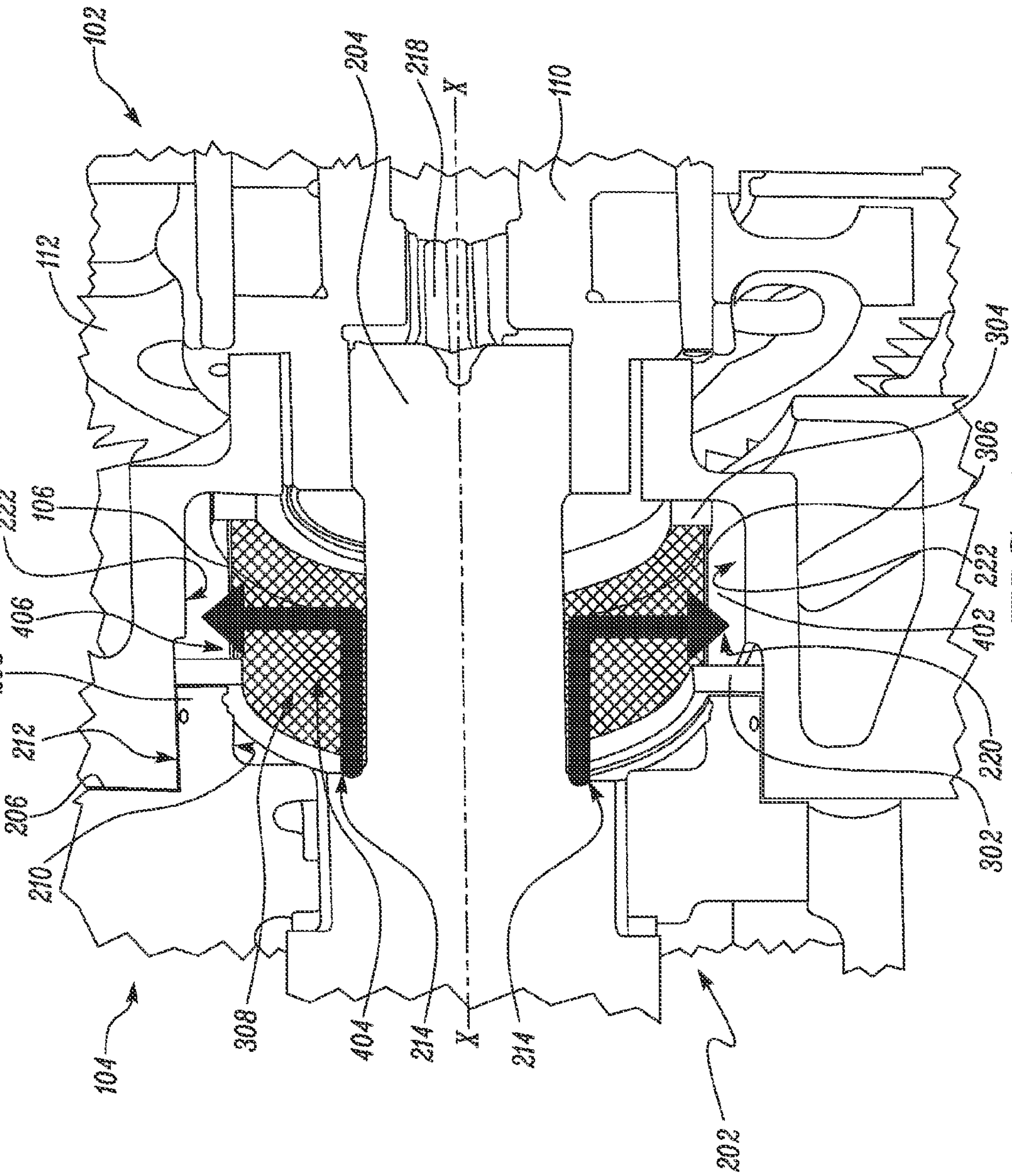


FIG. 3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306
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104
302
220
402
222

FIG. 4

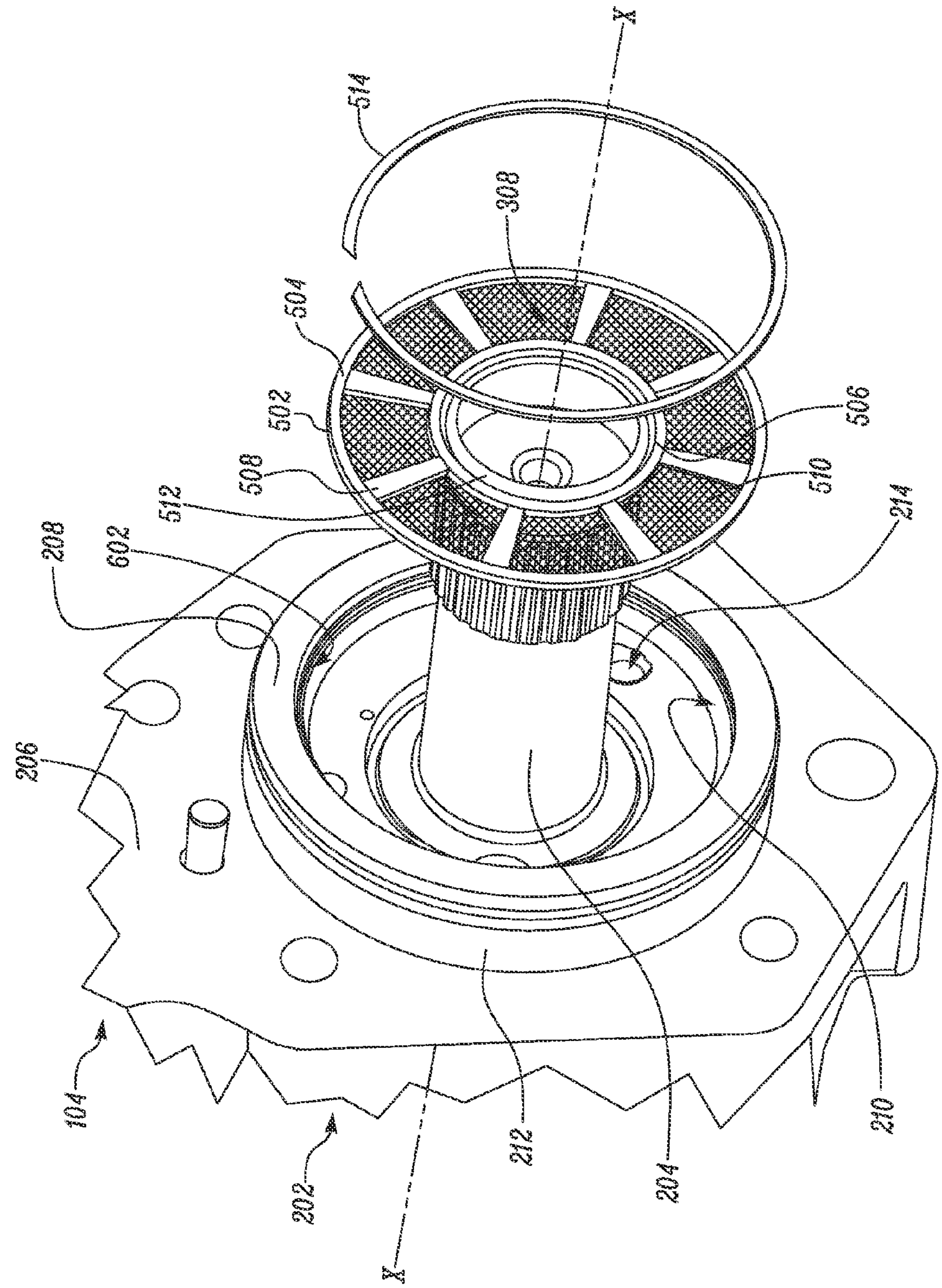
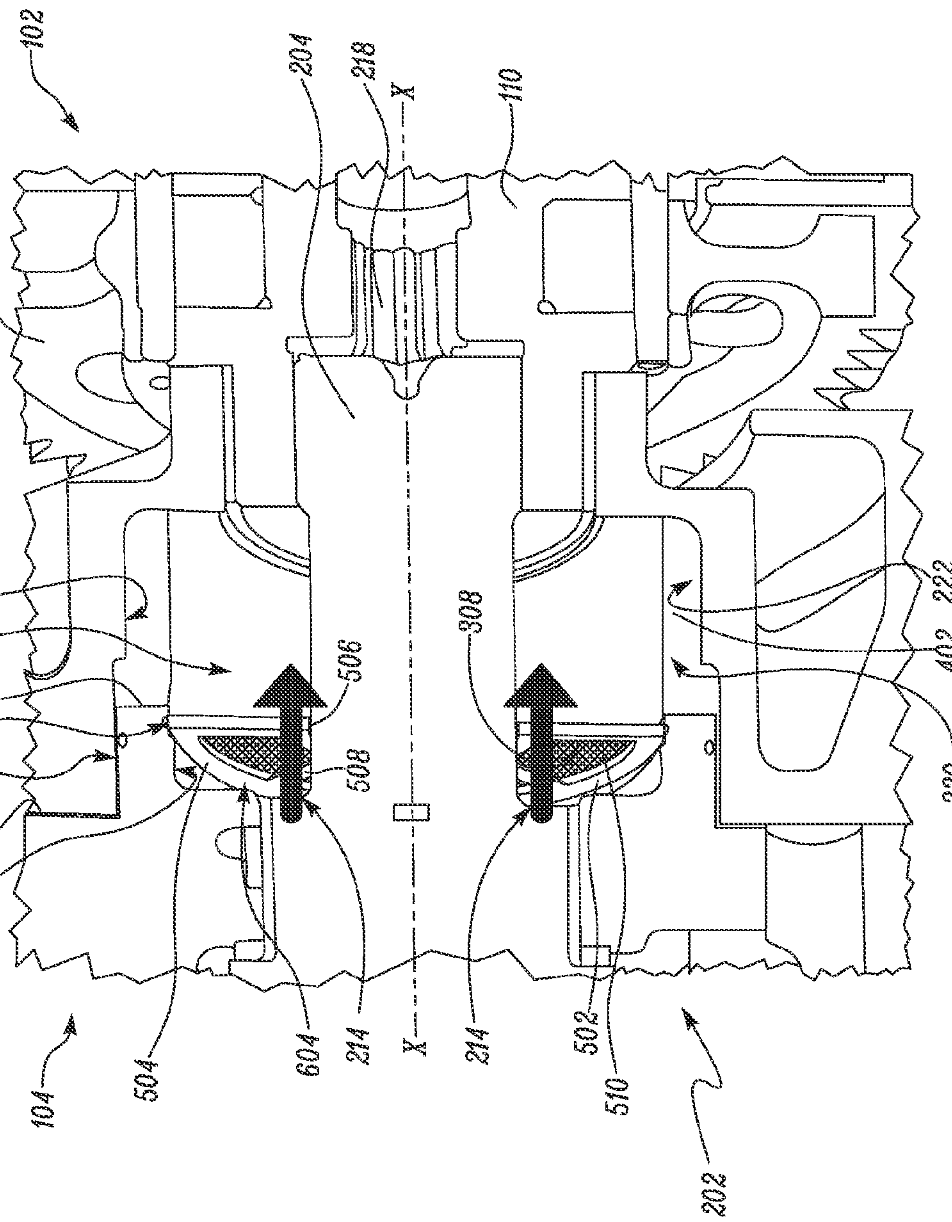

X
514
308
504
502
506
508
510
512
214
208
602
206
104
202
212
204
210
X

FIG. 5


102
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222
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208
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212
206
210
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604
214
X
214
502
510
202
104
506
508
308
222
402
220

FIG. 6

FUEL PUMP RETAINER

TECHNICAL FIELD

The present disclosure relates to a retainer, and more particularly to the retainer disposed within a fuel pump.

BACKGROUND

Fuel injectors are configured to inject a pressurized fuel into cylinders of an engine. The fuel injectors receive the pressurized fuel from a fuel pump through a fuel rail. The fuel pump is mechanically coupled and driven by a gear train present within a gear case associated with the engine. Further, the engine may also include an engine oil pump. The engine oil pump supplies a lubricating oil to the fuel pump and various engine components. The lubricating oil may drain from the fuel pump into the gear case.

In some situations, when the fuel pump fails, debris from the failed fuel pump may mix with the lubricating oil. This contaminated oil containing the debris may flow towards and enter into the gear train and/or other components of the engine positioned downstream of the fuel pump. Further, this may lead to failure of the respective gear train and/or the engine components. The failure of these engine components may increase a cost and downtime associated with an operation of the engine.

U.S. Pat. No. 7,699,738 discloses an oil pump structure of an automatic transmission. In the oil pump structure of an automatic transmission using a torque converter, a hydraulic pressure chamber is defined by pump housing and a pump cover, to rotatably accommodate therein inner and outer rotors. First and second inflow ports respectively communicating with an oil strainer and a control valve are formed in the outside surface of the pump cover separately from each other. First and second oil inflow passages communicating with the respective inflow ports, a merged-flow portion that downstream portions of the first and second oil inflow passages are merged with each other, a downstream-side oil distribution channel intercommunicating a downstream side of the merged-flow portion and the hydraulic pressure chamber, are formed in at least one of the pump housing and the pump cover.

SUMMARY OF THE DISCLOSURE

In one aspect of the present disclosure, a fuel pump is disclosed. The fuel pump includes a housing. Further, the fuel pump includes a rotatable pump shaft disposed within the housing. One end of the rotatable pump shaft is attachable to a gear. A retainer is disposed within the housing and located about the rotatable pump shaft. The retainer includes a first rim and a second rim. The first rim and the second rim of the retainer are spaced apart from each other. The retainer also includes a side wall extending between the first rim and the second rim. Further, the side wall of the retainer defines a first volume and a second volume within the housing. The side wall of the retainer has a plurality of apertures configured to allow a fluid flow from the first volume to the second volume, while retaining particulate contaminants larger than a size of the apertures within the first volume.

In another aspect, a fuel pump is disclosed. The fuel pump includes a housing with a rotatable pump shaft disposed within the housing. One end of the rotatable pump shaft is attachable to a gear. A retainer is disposed within the housing and located about the rotatable pump shaft. The retainer includes a first rim and a second rim, such that the first rim and the second rim are spaced apart from and coaxial to each other. The retainer includes a substantially planar wall attached to and extending between the first rim and the second rim. Further, the planar wall of the retainer defines a first volume and a second volume within the housing. The planar wall of the retainer includes a plurality of apertures configured to allow a fluid flow from the first volume to the second volume, while retaining particulate contaminants larger than a size of the apertures within the first volume.

In yet another aspect, an engine is disclosed. The engine includes an engine block. The engine also includes a gear case having a gear train. The gear train includes one or more gears. The engine further includes a fuel pump mechanically coupled to the gear train. The fuel pump includes a housing. A rotatable pump shaft is disposed within the housing such that one end of the rotatable pump shaft is configured to cooperate with a gear of the gear train. Further, a retainer is disposed within the housing and located about the rotatable pump shaft. The retainer includes a first rim and a second rim. The first rim and the second rim of the retainer are spaced apart from each other. The retainer also includes a wall extending between the first rim and the second rim. The wall of the retainer defines a first volume and a second volume within the housing. The wall of the retainer has a plurality of apertures configured to allow a fluid flow from the first volume to the second volume while retaining particulate contaminants larger than a size of the apertures within the first volume.

Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a perspective exploded view illustrating a retainer, a gear case and a fuel pump, according to an embodiment of the present disclosure;

FIG. **2** shows an exploded cross sectional view of the retainer, the fuel pump and the gear case;

FIG. **3** shows one configuration of the retainer, according to one embodiment of the present disclosure;

FIG. **4** shows a perspective cross sectional view of an assembly including the gear, the fuel pump and the retainer of FIG. **3**;

FIG. **5** is an exploded view of an alternate configuration of the retainer, according to another embodiment of the present disclosure; and

FIG. **6** shows a perspective cross sectional view of another assembly including the gear, the fuel pump and the retainer of FIG. **5**.

DETAILED DESCRIPTION

Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or the like parts. FIG. **1** illustrates a portion of an engine showing a gear case **102**, a fuel pump **104** and a retainer **106**. The engine may include an internal combustion engine that may be powered by any one or a combination of known liquid or gaseous fuels including, but not limited to, gasoline, diesel, natural gas, petroleum gas and bio-fuels. The gear case **102** includes a gear train **108** mounted on a gear plate **110**. The gear plate **110** is mounted on an engine block (not shown) of the engine. The gear case **102** may be attached to the engine block using any conventional fastening means such as, for example, bolts. The gear train **108** is employed between a crankshaft (not shown) and various engine components to allow for torque transmission. For example, the gear train **108** may include radial gears **112** (shown in FIG. **2**) for providing drive torque to the engine components like, for example, fuel pumps. Further, the gear train **108** may also includes idler gears for providing driving connections between the gears associated with the crankshaft and a camshaft (not shown), between the crankshaft and one or more of the radial gears **112** and so on.

The fuel pump **104** may be associated with the engine for delivery of pressurized fuel to a fuel rail (not shown) and into fuel injectors (not shown). During the operation of the engine, the fuel injectors are configured to inject the pressurized fuel into engine cylinders (not shown). The fuel pump **104** may include any of a gear pump, a trochoid pump, a vane pump, a plunger pump or any other pump known in the art based on system requirements. The fuel pump **104** is mechanically coupled to at least one gear **112** of the gear train **108**.

As illustrated in FIG. **2**, the fuel pump **104** may include a housing **202**. The fuel pump **104** also includes a rotatable pump shaft **204** extending along a longitudinal axis X-X defined by the pump shaft **204**. The housing **202** of the fuel pump **104** further includes a front face **206** and a mounting surface **208** extending axially from the front face **206**. The mounting surface **208** is disposed outwardly from and substantially coaxial with the longitudinal axis X-X. The mounting surface **208** includes an inner circumferential surface **210** and an outer circumferential surface **212**.

An engine oil pump (not shown) may be associated with the engine for supplying lubricating fluid, such as, for example, oil, to the fuel pump **104** and other engine components. Further, the fuel pump **104** includes a plurality of internal channels **214** defined along the front face **206** of the pump **104** surrounding the pump shaft **204**. The channels **214** provide a supply and return path for the lubricating oil.

One end of the pump shaft **204** is configured to be received by one of the gears **112** of the gear case **102**. The pump shaft **204** may be inserted into a splined gear shaft **218** associated with any gear **112** within the gear case **102**. During operation, the gear **112** may drive the pump shaft **204**, which in turn may cause the pump **104** to run. Referring to FIG. **2**, the gear case **102** may include a cavity **220** such that when assembled the cavity **220** cooperates with the mounting surface **208** and is configured to surround the pump shaft **204** when the fuel pump **104** is mounted. This cavity **220** on the gear case **102** may receive the lubricating oil draining out of the fuel pump **104** through the internal channels **214** provided therein.

A plurality of outlets **222** provided within the cavity **220** may provide a path for draining the lubricating oil from the fuel pump **104** into the gear case **102**. In one embodiment, a pair of the outlets **222** is provided diametrically opposite to each other in a direction perpendicular to the longitudinal axis X-X.

FIG. **3** is a perspective view of an embodiment the retainer **106** according to the present disclosure. The retainer **106** may be positioned about the pump shaft **204** within the housing **202**. FIGS. **1** to **4** show one configuration of the retainer **106**, according to one embodiment of the present disclosure. Another configuration of the retainer **502** will be explained with reference to FIGS. **5** and **6**.

Referring to FIG. **3**, the retainer **106** includes a first rim **302** and a second rim **304**. The first and second rims **302**, **304** of the retainer **106** have a circular ring like structure. Further, the first and second rims **302**, **304** of the retainer **106** are spaced apart from each other. As shown in FIGS. **1**, **2** and **4**, a diameter of the first and second rims **302**, **304** of the retainer **106** is greater than a diameter of the pump shaft **204**, such that the retainer **106** may surround the pump shaft **204**. In one embodiment, the diameter of first and second rims **302**, **304** of the retainer **106** may be approximately 3 to 5 times the diameter of the pump shaft **204**. As shown, an inner diameter of the first and second rims **302**, **304** may be substantially equal. It should be noted that the first and second rims **302**, **304** may be made of any metal or polymer material known in the art.

The retainer **106** also includes a side wall **306** extending between the first and second rims **302**, **304** of the retainer **106**. In one embodiment, the side wall **306** may extend axially between the first and second rims **302**, **304** such that, the side wall **306** may be substantially parallel to the longitudinal axis X-X of the pump shaft **204**. In one embodiment, the side wall **306** may have a cylindrical configuration. Alternatively, in another embodiment, when the diameter of the first rim **302** is greater than the diameter of the second rim **304**, the side wall **306** may be disposed between the first and second rims **302**, **304** such that the cross section of the side wall **306** may gradually taper between the first and second rims **302**, **304**.

The side wall **306** of the retainer **106** includes a plurality of apertures **308**. These apertures **308** may be circular holes, slots or may have any other shape. The apertures **308** of the side wall **306** may serve as a filter for preventing particulate contaminants having a size larger than a size of the apertures **308** from flowing towards the gear case **102** from the fuel pump **104**. One of ordinary skill in the art will appreciate that the size of the apertures **308** must be so chosen that the comparatively larger particulate contaminants are separated and retained within the retainer **106**, while the oil may be allowed to flow towards the gear case **102** through the retainer **106**. In one embodiment, a multi-layer side wall **306** may be used for providing additional support. For example, the retainer **106** may include a three layered side wall **306**.

Further, a mesh **310** may be provided on the side wall **306** of the retainer **106**. The mesh **310** is positioned such that the mesh **310** may be located on an outer surface of the side wall **306** away from the pump shaft **204** when the retainer **106** is assembled thereon. The mesh **310** may provide mechanical strength to the side wall **306** of the retainer **106**. It should be noted that the side wall **306** and the mesh **310** may be made from any metal or polymer known in the art, for example, aluminum, steel, polytetrafluoroethylene (PTFE), polyvinylchloride (PVC) and the like.

Operation of the retainer **106** will now be described in detail. FIG. **4** is a perspective view of a cross section of the retainer **106**, the fuel pump **104** and the gear case **102**. When assembled, the outer circumference **212** of the mounting surface **208** of the fuel pump **104** is in contact with and rests within an inner surface **402** of the cavity **220**. The retainer **106** is located about the pump shaft **204** such that the retainer **106** is positioned within the cavity **220**.

Lubricating oil may drain from the fuel pump **104**, through the retainer **106**, and into the gear case **102**. The side wall **306** of the retainer **106** defines a first volume **404** and a second volume **406** with respect to the oil flow from the fuel pump **104** into the gear case **102**. The first volume **404** is defined on an interior side of the side wall **306** with respect to the oil flow, between the side wall **306** and the pump shaft **204**. The second volume **406** is defined on an outer side of the side wall **306** with respect to the oil flow. In the illustrated embodiment, the second volume **406** may be positioned radially outwards of the first volume **404** and in oil communication with the gear train **108** of the gear case **102**.

As shown by arrows in the accompanying figures, the lubricating oil may flow along the longitudinal axis X-X of the pump shaft **204**. The oil may flow out of the first volume **404** by being routed through the side wall **306** of the retainer **106** in a radial direction. The plurality of apertures **308** provided in the side wall **306** may allow for the particulate contaminants present within the oil flow to be retained within the first volume **404**. Apertures **308** are sized to be smaller than contaminants that may physically damage the gear train **108** yet large enough to allow lubricating oil to flow through without a significant pressure drop. For example, the apertures **308** may be sized as small as approximately 100 microns. In another example, the apertures **308** may be larger than 100 microns. The size of the apertures **308** may vary based on the level of protection required. Thus, the lubricating oil is separated of the contaminants and may flow into the second volume **406** and drain into the gear case **102** through the outlets **222**.

FIGS. **5** and **6** illustrate a second configuration of the retainer **502**, according to another embodiment of the present disclosure. As shown in FIG. **5**, the retainer **502** includes the first rim **504** and the second rim **506** having a circular ring like structure. The first and second rims **504**, **506** of the retainer **502** are coaxial and spaced apart from each other in the radial direction. More particularly, the first and second rims **504**, **506** of the retainer **502** are substantially concentric to each other.

In the illustrated embodiment, the first rim **504** of the retainer **502** has a diameter greater than that of the second rim **506**. For example, the diameter of the first rim **504** may have a diameter 3 to 5 times of the diameter of the second rim **506**. Also, the diameter of the second rim **506** may be substantially equal to the diameter of the pump shaft **204** such that the second rim **506** may fit closely around the pump shaft **204**. Further, in one embodiment, a plurality of support ribs **508** may be provided on the retainer **502** in a spaced apart arrangement. The support ribs **508** may extend radially between the first and second rims **504**, **506**.

The retainer **502** also includes a substantially planar wall **510** attached to and extending between the first and second rims **504**, **506**. The planar wall **510** of the retainer **502** is perpendicular to the longitudinal axis X-X. As shown, the first and second rims **504**, **506** of the retainer **502** are configured as concentric circles in the same plane as the planar wall **510**. The planar wall **510** may include the plurality of apertures **308**.

In one embodiment, a sealing ring **512** may be provided between the pump shaft **204** and the second rim **506** in order to dynamically seal the second rim **506** of the retainer **502** and the pump shaft **204**. Additionally, another sealing ring **514** may also be provided between the first rim **504** of the retainer **502** and the inner circumference **210** of the mounting surface **208** in order to prevent an out flow of the oil when the pump shaft **204** rotates.

FIG. **6** shows a cross sectional view of the retainer **502** provided within the housing **202** of the fuel pump **104**. In the present embodiment, the retainer **502** may be received into a groove **602** provided on the inner circumference **210** of the mounting surface **208** of the fuel pump **104**. Further, the retainer **502** defines the first volume **604** and the second volume **606** within the housing **202** of the fuel pump **104** and the gear case **102** respectively. More particularly, the first volume **604** is defined on the interior side and the second volume **606** is defined on the exterior side of the planar wall **510** with respect to the direction of the oil flow. As shown by arrows, the oil may flow in the axial direction from the fuel pump **104** through the retainer **502** towards the gear case **102**. The plurality of apertures **308** on the planar wall **510** may retain the particulate contaminants within the first volume **604** and prevent the particulate contaminants from entering into the second volume **606**. For example, the apertures **308** may be sized as small as approximately 100 microns. In another example, the apertures **308** may be larger than 100 microns. The size of the apertures **308** may vary based on the level of protection required.

Industrial Applicability

Debris resulting from a catastrophic failure of the fuel pump may mix with the lubricating oil draining from the fuel pump into the gear case. This debris which is mixed with the oil may cause damage to the engine gear train and/or associated components of the engine present downstream of the drained oil flow.

The retainer **106**, **502** disclosed herein is disposed about the pump shaft **204**. The plurality of apertures **308** present on the retainer **106**, **502** may prevent the debris or the particulate contaminants from flowing downstream into the gear case **102**. The retainer **106**, **502** may contain or collect these particulate contaminants within an area or cavity defined in relation with the retainer **106**, **502** and thereby prevent damage to the gear train **108** present within the gear case **102**.

While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed machines, systems and methods without departing from the spirit and scope of what is disclosed. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof

What is claimed is:

1. A fuel pump comprising:
- a housing;
- a rotatable pump shaft disposed within the housing, one end of the rotatable pump shaft being attachable to a gear; and
- a retainer disposed within the housing and located about the rotatable pump shaft, the retainer comprising:
  - a first rim and a second rim, wherein the first rim and the second rim are spaced apart from each other; and
  - a side wall attached to and extending between the first rim and the second rim, the side wall having a plurality of apertures, the side wall defining a first and second volume within the housing, wherein the plurality of apertures is configured to allow a fluid flow from the first volume to the second volume while retaining particulate contaminants larger than a size of the apertures within the first volume.

2. The fuel pump of claim **1**, wherein the first volume is defined on an interior side and the second volume is defined on an exterior side of the side wall with respect to the pump shaft, the exterior side being positioned radially outwards of the interior side.

3. The fuel pump of claim **1**, wherein the first rim and the second rim are configured to have a circular ring-like structure.

4. The fuel pump of claim further **1**, comprising a mesh disposed on a surface of the side wall configured to provide mechanical strength.

5. The fuel pump of claim **1**, wherein a diameter of the first rim and a diameter of the second rim is greater than a diameter of the pump shaft.

6. A fuel pump comprising:
- a housing;
- a rotatable pump shaft disposed within the housing, one end of the rotatable pump shaft being attachable to a gear; and

a retainer disposed within the housing and located about the rotatable pump shaft, the retainer comprising:

a first rim and a second rim, wherein the first rim and the second rim are spaced apart from and coaxial to each other; and

a substantially planar wall attached to and extending between the first rim and the second rim , the planar wall having a plurality of apertures, the surface defining a first and second volume within the housing, wherein the plurality of apertures is configured to allow a fluid flow from the first volume to the second volume while retaining particulate contaminants larger than a size of the apertures within the first volume.

7. The fuel pump of claim **6**, wherein the first volume is defined on an interior side and the second volume is defined on an exterior side of the planar wall with respect to a direction of the fluid flow.

8. The fuel pump of claim **6**, wherein the first rim and the second rim are configured as concentric circles in the same plane as the planar wall.

9. The fuel pump of claim **8** further comprising a plurality of support ribs provided in a spaced apart arrangement and radially extending between the first rim and the second rim.

10. The fuel pump of claim **8**, wherein a diameter of the second rim is substantially equal to a diameter of the pump shaft.

11. The fuel pump of claim **8**, wherein a diameter of the first rim is greater than a diameter of the second rim.

12. The fuel pump of claim **8** further comprising a sealing ring provided between the pump shaft and the second rim.

13. An engine comprising:

an engine block;

a gear case having a gear train comprising one or more gears; and

a fuel pump mechanically coupled to the gear train, the fuel pump comprising:

a housing;

a rotatable pump shaft disposed within the housing, one end of the rotatable pump shaft being configured to cooperate with a gear of the gear train; and

a retainer disposed within the housing and located about the rotatable pump shaft, the retainer comprising:

a first rim and a second rim, wherein the first rim and the second rim are spaced apart from each other; and

a wall extending between the first rim and the second rim, the wall having a plurality of apertures, the wall defining a first and second volume within the housing, wherein the plurality of apertures is configured to allow a fluid flow from the first volume to the second volume while retaining particulate contaminants larger than a size of the apertures within the first volume.

14. The engine of claim **13**, wherein the second volume is in fluid communication with the gear train.

15. The engine of claim **13**, wherein the first volume is defined on an interior side and the second volume is defined on an exterior side of the wall with respect to the pump shaft, the exterior side being positioned radially outwards of the interior side.

16. The engine of claim **13**, wherein the first rim and the second rim are configured to have a circular ring like structure.

17. The engine of claim **13** further comprising a mesh disposed on a surface of the wall for providing mechanical strength.

18. The engine of claim **13**, wherein a diameter of the first rim and a diameter of the second rim is substantially greater than a diameter of the pump shaft.

19. The engine of claim **13**, wherein the first rim and the second rim are configured as concentric circles in the same plane as the planar wall.

20. The engine of claim **19**, wherein the second rim is substantially equal to a diameter of the pump shaft.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,181,909 B2
APPLICATION NO. : 14/028595
DATED : November 10, 2015
INVENTOR(S) : Unes et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims

Column 6, line 57, claim 4, delete “The fuel pump of claim further 1,” and insert -- The fuel pump of claim 1, further --.

Signed and Sealed this
Eighteenth Day of October, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office